CONFIRMATION

PATENT COOPERATION TREATY

PCT

INTERNATIONAL PRELIMINARY REPORT ON PATENTABILITY

(Chapter II of the Patent Cooperation Treaty)

(PCT Article 36 and Rule 70)

Applicant's or agent's file reference 20401156KC	FOR FURTHER ACTION	See Form PCT/IPEA/416
International application No. PCT/SG2004/000210	International filing date *(day/month/year)* 13 July 2004	Priority date *(day/month/year)* 25 July 2003
International Patent Classification (IPC) or national classification and IPC **Int. Cl.** [7] H01J 37/04, H05H 1/46		
Applicant NANYANG TECHNOLOGICAL UNIVERSITY et al		

This report is the international preliminary examination report, established by this International Preliminary Examining Authority under Article 35 and transmitted to the applicant according to Article 36.

2. This REPORT consists of a total of 3 sheets, including this cover sheet.

3. This report is also accompanied by ANNEXES, comprising:

a. [X] *(sent to the applicant and to the International Bureau)* a total of 4 sheets, as follows:

- [ ] sheets of the description, claims and/or drawings which have been amended and are the basis for this report and/or sheets containing rectifications authorized by this Authority (see Rule 70.16 and Section 607 of the Administrative Instructions).
- [ ] sheets which supersede earlier sheets, but which this Authority considers contain an amendment that goes beyond the disclosure in the international application as filed, as indicated in item 4 of Box No. I and the Supplemental Box.

b. [ ] *(sent to the International Bureau only)* a total of (indicate type and number of electronic carrier(s)) , containing a sequence listing and/or table related thereto, in computer readable form only, as indicated in the Supplemental Box Relating to Sequence Listing (see Section 802 of the Administrative Instructions).

4. This report contains indications relating to the following items:

- [X] Box No. I Basis of the report
- [ ] Box No. II Priority
- [ ] Box No. III Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
- [ ] Box No. IV Lack of unity of invention
- [X] Box No. V Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement
- [ ] Box No. VI Certain documents cited
- [ ] Box No. VII Certain defects in the international application
- [ ] Box No. VIII Certain observations on the international application

Date of submission of the demand 8 February 2005	Date of completion of the report 9 September 2005
Name and mailing address of the IPEA/AU AUSTRALIAN PATENT OFFICE PO BOX 200, WODEN ACT 2606, AUSTRALIA E-mail address: pct@ipaustralia.gov.au Facsimile No. (02) 6285 3929	Authorized Officer **BAYER MITROVIC** Telephone No. (02) 6283 2164

INTERNATIONAL PRELIMINARY REPORT ON PATENTABILITY

International application No.
PCT/SG2004/000210

Box No. I Basis of the report

1. With regard to the **language**, this report is based on the international application in the language in which it was filed, unless otherwise indicated under this item.

☐ This report is based on translations from the original language into the following language , which is the language of a translation furnished for the purposes of:

☐ international search (under Rules 12.3 and 23.1 (b))

☐ publication of the international application (under Rule 12.4)

☐ international preliminary examination (under Rules 55.2 and/or 55.3)

2. With regard to the **elements** of the international application, this report is based on (*replacement sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are not annexed to this report*):

☐ the international application as originally filed/furnished

☒ the description:

pages **1-15** as originally filed/furnished
pages* received by this Authority on with the letter of
pages* received by this Authority on with the letter of

☒ the claims:

pages as originally filed/furnished
pages* as amended (together with any statement) under Article 19
pages* **16-19** received by this Authority on **31 August 2005** with the letter of **31 August 2005**
pages* received by this Authority on with the letter of

☒ the drawings:

pages **1/8-8/8** as originally filed/furnished
pages* received by this Authority on with the letter of
pages* received by this Authority on with the letter of

☐ a sequence listing and/or any related table(s) - see Supplemental Box Relating to Sequence Listing.

3. ☐ The amendments have resulted in the cancellation of:

☐ the description, pages
☐ the claims, Nos.
☐ the drawings, sheets/figs
☐ the sequence listing (*specify*):
☐ any table(s) related to the sequence listing (*specify*):

4. ☐ This report has been established as if (some of) the amendments annexed to this report and listed below had not been made, since they have been considered to go beyond the disclosure as filed, as indicated in the Supplemental Box (Rule 70.2(c)).

☐ the description, pages
☐ the claims, Nos.
☐ the drawings, sheets/figs
☐ the sequence listing (*specify*):
☐ any table(s) related to the sequence listing (*specify*):

* *If item 4 applies, some or all of those sheets may be marked "superseded."*

INTERNATIONAL PRELIMINARY REPORT ON PATENTABILITY

International application No.
PCT/SG2004/000210

Box No. V Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. Statement

Novelty (N)	Claims	1-18	**YES**
	Claims		**NO**
Inventive step (IS)	Claims	1-18	**YES**
	Claims		**NO**
Industrial applicability (IA)	Claims	1-18	**YES**
	Claims		**NO**

2. Citations and explanations (Rule 70.7)

Citation:
D1: US 6501447
D2: GANTER ET AL:" EFFICIENCY OF AC PLASMA DISPLAY PANELS FROM DIAGNOSTICS AND MODELS", Appl.Surf.Sci.vol.192, no.1, pp.299-308 (2002) (preprint from www.iquesta.com/articles/plasma.PDF)

Both documents D1 and D2 disclose a plasma display panels having perpendicular electrodes generating radiofrequency discharge. However, none of the documents disclose plasma reactor/method for generating uniform plasma using unidirectional oscillating RF current at a frequency range of 300-1000kHz.

CLAIMS 1-18 NOVELTY AND INVENTIVE STEP

Claims 1-18 meet the criteria set forth in PCT Article 33(2) for novelty and article 33(3) for inventive step. The prior art published before the priority date does not disclose or obviously suggest to a person skilled in the art the plasma reactor/method for generating uniform plasma using unidirectional oscillating current at a frequency range of 300-1000kHz

CLAIMS 1-18 INDUSTRIAL APPLICABILITY

Invention defined in claims 1-18 is industrially applicable.

Claims

1. A method for generating a uniform plasma, the method comprising the steps:
   a. introducing a process gas into a plasma reactor;
   b. introducing an RF antenna having a first unidirectional oscillating current in a first direction and a second unidirectional oscillating current in a second direction inside the plasma reactor; and
   c. the first unidirectional oscillating RF current sheet is substantially perpendicular to the second unidirectional oscillating current sheet
   wherein the unidirectional oscillating RF currents are oscillating at a frequency range of 300 to 1000 kHz.

2. The method in accordance with claim 1, further wherein the RF antenna having first and second unidirectional oscillating currents generate a time varying RF electrical field azimuthally shifted on 45° with respect to the first and second direction of the first and second unidirectional oscillating RF currents.

3. The method in accordance with claim 1, wherein the process gas comprises: argon, nitrogen, methane, or hydrogen or a combination of any of the mentioned gases.

4. The method in accordance with claim 1, wherein the first and second unidirectional oscillating RF currents exhibit substantially no phase differences.

5. A method for generating a uniform plasma, the method comprising the steps:
   a. introducing a process gas into a plasma reactor;
   b. introducing a unidirectional oscillating RF current into a first plurality of current carrying conductors in a first direction and a second plurality of current carrying conductors in a second direction;
   c. generating a time varying RF electrical field azimuthally shifted with respect to the first and second direction of the unidirectional oscillating RF currents; and
   d. the unidirectional oscillating RF current in the first and second plurality of current carrying conductors exhibit substantially no phase differences;

wherein the unidirectional oscillating RF current is oscillating at a frequency range of 300 to 1000 kHz.

6. The method in accordance with claim 5, wherein the process gas comprises: argon, nitrogen, methane, or hydrogen or a combination of any of the mentioned gases.

7. A method for generating a uniform plasma, the method comprising the steps:

a. introducing a process gas into a plasma reactor:

b. introducing a first unidirectional oscillating RF current into a first plurality of current carrying conductors in a first direction;

c. introducing a second unidirectional oscillating RF current into a second plurality of current carrying conductors in a second direction;

d. generating a time varying RF electrical field azimuthally shifted with respect to the first and second direction of the first and second unidirectional oscillating RF currents; and

e. the first and second unidirectional oscillating RF currents exhibit substantially no phase differences;

wherein the first and second unidirectional oscillating RF currents are oscillating at a frequency range of 300 to 1000 kHz.

8. The method in accordance with claim 7, wherein the process gas comprises: argon, nitrogen, methane, or hydrogen or a combination of any of the mentioned gases.

9. A method for generating a uniform plasma, the method comprising the steps:

a. introducing a process gas into a plasma reactor;

b. introducing a unidirectional oscillating RF current into a first plurality of current carrying conductors in a first direction;

c. introducing the unidirectional oscillating RF current into a second plurality of current carrying conductors in a second direction;

d. generating a time varying RF electrical field azimuthally shifted with respect to the first and second direction of the unidirectional oscillating RF currents; and

e. the unidirectional oscillating RF current in the first and second plurality of current carrying conductors exhibit substantially no phase differences;

wherein the unidirectional oscillating RF current is oscillating at a frequency range of 300 to 1000 kHz.

10. The method in accordance with claim 92, wherein the process gas comprises: argon, nitrogen, methane, or hydrogen or a combination of any of the mentioned gases.

11. An antenna arrangement for an inductively coupled plasma reactor comprising:

a first plurality of substantially parallel current carrying conductors oriented in a first direction;

a second plurality of substantially parallel current carrying conductors oriented in a second direction;

the first and second current carrying conductors for carrying unidirectional oscillating RF currents in a first and second direction respectively;

the first direction being substantially perpendicular to the second direction;

the first plurality of substantially parallel current carrying conductors is disposed planarly above the second plurality of substantially parallel current carrying conductors; and

wherein the unidirectional oscillating RF current is oscillating at a frequency range of 300 to 1000 kHz.

12. The antenna arrangement in accordance with claim 11, wherein the first and second plurality of substantially parallel current carrying conductors adapted to generate a time varying RF electrical field azimuthally shifted on 45° with respect to the first and second direction.

13. The antenna arrangement in accordance with claim 11, wherein the first plurality of substantially parallel current carrying conductors are alternately electrically coupled to the second plurality of substantially parallel current carrying conductors.

14. The antenna arrangement in accordance with claim 13, wherein at least one capacitor is connected between a predetermined number of the first plurality of substantially parallel current carrying conductors and a predetermined number of the second plurality of substantially parallel current carrying for minimizing reactance.

15. A plasma reactor comprising:

a. a plasma reactor chamber adapted for plasma processing and for introducing of a process gas; and

b. an RF antenna arrangement comprising a first plurality of substantially parallel current carrying conductors in a first direction;

c. a second plurality of substantially parallel current carrying conductors in a second direction;

d. the first and second plurality of current carrying conductors for carrying unidirectional oscillating RF currents in a first and second direction respectively; and the first direction being substantially perpendicular to the second direction; and

e. the first plurality of substantially parallel current carrying conductors is disposed planarly above the second plurality of substantially parallel current carrying conductors;

wherein the unidirectional oscillating RF current is oscillating at a frequency range of 300 to 1000 kHz.

16. The inductively coupled plasma reactor in accordance with claim 15, wherein the first and second plurality of substantially parallel current carrying conductors are disposed inside the plasma reactor chamber.

17. The inductively coupled plasma reactor in accordance with claim 15, wherein each of the first and second plurality of substantially parallel current carrying conductors is contained inside each of a plurality of dielectric sleeves.

18. The inductively coupled plasma reactor in accordance with claim 17, wherein the plasma reactor chamber is adapted to accommodate the plurality of dielectric sleeves and still maintain vacuum integrity of the plasma reactor chamber.